PAPERS SUPPLEMENTING THE DISCUSSION OF THE WEST INDIAN HURRICANE OF SEPT. 6–14, 1919.

A TORNADO WITHIN A HURRICANE AREA.

By RICHARD W. GRAY, Meteorologist.

A tornado occurred at Goulds, Fla., a small town 20 miles southwest of Miami, on September 10, 1919, between 1:00 p. m. and 1:15 p. m., eastern summer time.

This tornado is of special interest in that it can be said to have occurred within a hurricane area. The severe tropical disturbance that passed through the Florida Straits and, several days later, caused such an appalling loss of life and destruction of property at Corpus Christi, Tex., was central during the afternoon of September 10 over the extreme southeastern Gulf of Mexico. The center of this storm, therefore, was probably within 125 miles of the path of the tornado, and the southern part of the Florida peninsula was still under its influence.

The high winds that prevailed over extreme southern Florida in connection with the tropical storm had diminished by the morning of the 10th, but a moderate gale was still blowing, and the wind continued at this force at Goulds until just before the occurrence of the tornado, when there was a lull for probably 15 minutes.

The tornado developed either over the ocean or Biscayne Bay, and its original form was undoubtedly that of a waterspout. It moved in a west-northwest direction, directly with the strong southeast wind that prevailed at the time on the southeast Florida coast. After leaving the bay, it crossed a 3-mile stretch of marsh land, and there were evidences that this part of the path was extremely narrow. It then entered a pine wood immediately east of Goulds, where the path rapidly widened. At Goulds, the path was about 600 feet in width. After passing over Goulds, the storm moved over a cleared area of about one-half mile in extent, when it entered another pine wood. It is interesting to note that the path through this second wood was 100 feet, or less, in width. The storm continued west-northwest, and was seen to disappear over the Everglades, about 14 miles from the point of entry on the shore of Biscayne Bay. Fig. 1 shows the tornado path.

The tornado was attended by the characteristic pendant cloud, which was described by several persons as having a waving motion, with the detached end apparrently moving through a space of 100 feet. It was not accompanied by rain, but the air in the path of the storm was filled with a fine mist.

There were many evidences of the whirling motion of the air. In the first wood through which the storm passed (fig. 2), the uprooted and broken trees apparently fell in all directions. At Goulds, débris from a demolished building was carried across the path of the storm and deposited on the side opposite to which the building stood. A hotel and a large packing house, which were on the northern edge of the path, were lifted from their foundations and moved 15 feet toward the center of the path.

In the second wood (fig. 4), where the path had narrowed to 100 feet, or less, there was no indication of a whirl. All the fallen trees, with one exception, lay with their tops toward the northwest, being practically parallel. One tree which fell toward the southwest was apparently leaning in that direction before the storm occurred. The fallen trees in this narrow part of the path indicated a straight blow, and it was apparently here that the storm developed its greatest force. A dwelling in a small clearing in this wood was completely demolished, and the concrete foundations of the house were pulled out of the ground. Many of the trees had large pieces of tin and sheet-iron roofing wrapped around them, or lodged in their tops (figs. 4 and 5), these pieces of roofing being part of the débris from wrecked buildings at Goulds, about 1 mile to the east.

At Goulds, 19 buildings were damaged and 6 were demolished. Some of the damaged buildings will have to be practically rebuilt. The monetary loss was approximately $25,000.

There was no loss of life in connection with the storm, but five persons were injured by flying débris, and one girl was seriously cut by a piece of flying glass. The absence of fatal accidents was due to the fact that the occupants of all buildings that were demolished heard the approaching storm in time to escape into the open, where they threw themselves upon the ground.

In one instance, five persons escaped injury by taking refuge behind a large boiler. This boiler was struck by pieces of flying timber from the building that had just been vacated.

In another case, a man ran out of the rear of a building just as it was on the point of collapsing The roof of the building passed over his head, and he was uninjured.

Mr. W. H. Cawley saw the storm approaching, and, getting into his automobile, he started for his home, which is a short distance west of Goulds. He was overtaken by the storm and by flying débris, and a large piece of sheet iron struck the top of the automobile and cut it off, without otherwise damaging the car. Upon arriving home, Mr. Cawley found that his residence was intact, but that his garage, which was within 50 feet of the house, had been demolished.

The post office was one of the buildings completely destroyed, and the postmaster escaped from the building only a few seconds before it was razed. Fortunately, he ran to the rear of a packing house, which, though lifted from its foundations, was not blown down. He was thus protected from flying débris, with which, he states, the air seemed to be filled.

TORNADO NEAR HOBBS, N. MEX., SEPTEMBER 19, 1919.

By E. H. BYERS, Cooperative Observer.

NOTE.—So far as is known this is the first account of a real tornado within the borders of this State. Hobbs is in the extreme southeast border county of the State in a flat, open prairie country.—*C. E. Linney, Section Director.*

About 4 o'clock on the afternoon of the 19th of September, 1919, a small tornado formed south by east of this station (Hobbs, Lea County, N. Mex.), at a distance of about 4 miles. (See map, p. 640.) A shower first formed to the southeast, with a heavy electrical display, strato-cumulus clouds gathering on the extreme west of this formation, in which a funnel-shaped cloud formed and let down from the general level of the surrounding clouds. This funnel pointed westward to where it hit the ground at an angle of about 45°. It traveled over the ground in a direction south of west for a distance of about 1 mile. Fortunately, there were no permanent improvements in its pathway, so that no damage was done, except to destroy some little vegetation which lay in its way. Its course was marked by a column of red dust, which gradually grew thinner, until

it broke about the middle. All this time the thunderstorm was moving northeast, and the appearance was as if the shower drew the tornado apart.

Its pathway was very narrow, probably at no time over 100 yards wide. This storm preceded the night on which occurred one of the most severe electrical storms which this country has ever known, and to the west of this station the heaviest rain they have had in many years, thus completing a very unusual and remarkable 24 hours.

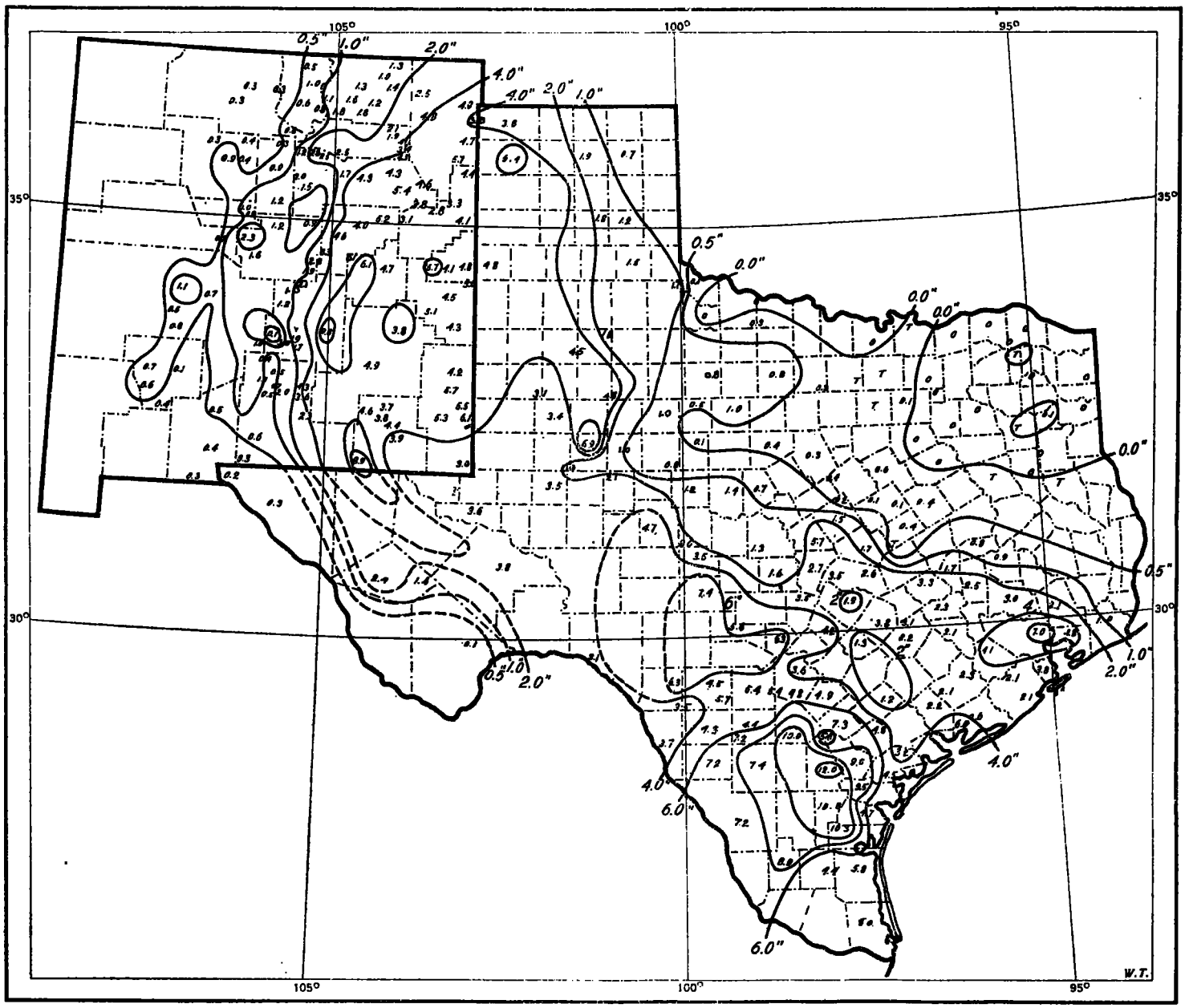

FIG. 1.—Rainfall accompanying the West Indian hurricane Sept. 14-17, 1919. (The short dash in southeastern New Mexico indicates where a tornado occurred.)

HEAVY RAINFALL IN NEW MEXICO SEPTEMBER 14-17, 1919.

The aftermath of the West Indian hurricane, which caused such havoc at Corpus Christi and the immediate Gulf coast on the 14th of September, 1919, was noted as far west as the Rio Grande Valley of New Mexico. Rain began to fall along the southeast border on the night of the 14th, and as far west as the Rio Grande on the afternoon of the 15th, continuing till the forenoon of the 16th in the Rio Grande Valley and until the late night of the 16th from about the one hundred and fifth meridian eastward. The fall in the Rio Grande Valley ranged from about a quarter of an inch to more than an inch, increasing on the eastern slopes of the guarding mountains to more than 2 inches in many localities, but again falling below an inch over the eastern part of the Estancia Valley and the Tularosa Basin. The fall over the southeast mountains and generally to the east of the central mountain areas of the State again increased rapidly to 2, 3, 4, or more inches, with a maximum fall of 9.76 inches at Meek, eastern Lincoln County, while 8.85 inches occurred at the Carson sheep-ranger station, on the eastern slope of the Guadalupe Mountains, western Eddy County. Over the Pecos Valley and the eastern plains 4 to 5 inches occurred, giving, as a whole, the heaviest rainstorm which has visited the State in many years.

Scores of stations recorded excessive precipitation, since most of the downpour occurred on the 15th–16th,

but the measurement of 7.71 inches in 24 hours at Meek is the greatest of record. This occurred from 5 p. m. of the 15th to 5 p. m. of the 16th. The storm beginning at 5 a. m. of the 16th and ending at 11 p. m. of the 16th, gave a measured fall of 9.76 inches for the period, an amount approximating some of the heavy downpours of the Tropics.—*C. E. Linney.*

The accompanying map (fig. 1) shows the distribution of rainfall in Texas as well as New Mexico, September 14–17. For a few coast stations, where rain from the West Indian hurricane began on the 13th, the amounts for this day are included. Where the heaviest winds blew on-shore, the greatest rainfall (12 inches) is a little way inland rather than on the coast, possibly because friction with the land brought the maximum ascensional movement of the air a short distance inland. Another zone of maximum precipitation marks the Edwards Plateau and High Plains.—*C. F. B.*

INFLUENCE OF TROPICAL CYCLONES ON THE WEATHER IN THE VALLEY OF MEXICO.

(By E. Lopez, Bol. Mensual del Observatorio Meteorol. y Seismol. Central de Mexico, 1916, No. 10, pp. 203-206, map. Abstract reprinted from *Geog. Rev.*, June 1918, p. 508.)

From time to time extraordinary rainfalls have been recorded in Mexico City; in September, 1915, for instance, 3½ inches of rain fell in four hours. These are hurricane rains developing in the rear quadrant of the violent tropical cyclone. In the above article, meteorological conditions during eight such storms are shown in tabular form, the paths of the storms being indicated on a map.

EARLY TEXAS COAST STORMS.

(Condensed from the mms. of "Texas Coast Storms," written by Ben C. Stuart and presented to Dr. B. Bunnemeyer of the United States Weather Bureau at Houston, Tex.)

While severe storms swept the coast of Texas long before the dawn of history, the first authentic record we have dates from September 4, 1766, when, according to the Spanish chroniclers, a severe gale visited Galveston Bay. An Indian mission and presidio called San Augustin de Ahumado had been located in what is now Chambers County, and thought to have been situated on or near Lake Charlotte, which connects with the Trinity just north of the present settlement of Wallisville. The wind greatly damaged the mission buildings, and the water from the bay and river submerged the land, which was only a few feet (probably 6 or 8) above ordinary tide. The disaster resulted in the abandonment of the mission. Lake Charlotte is 6 miles from the mouth of the Trinity River, and more than 50 miles from the Gulf of Mexico. The same spot was submerged during the hurricane of August 16–17, 1915.

As the coast of Texas was uninhabited for many years, save by roving bands of savages—the Opelousas, near Sabine Lake and along Bolivar Peninsula, and the Carancahuas and Cokes from Galveston Island as far west as Aransas, and possibly to the vicinity of the Rio Grande—there is no record of hurricanes until the occupation of Galveston Island by Lafitte in 1817, and the earliest report of one comes from statements made by James Campbell, who was in the service of Lafitte and Col. Warren D. C. Hall, an officer under Gen. James Long, who was operating against the Spaniards, and who visited Galveston Island to attempt to enlist Lafitte in the enterprise, but without success. According to them the island was visited by a severe hurricane, the wind being from the east and northeast, and veering to the northwest. The exact date of the storm has not been preserved, but it was in September or October, 1818. The entire island was submerged, with the exception of a small spot on the east end, near the present site of the State Medical College. Lafitte's huts on shore were badly damaged, and several of the vessels cast ashore or sunk. There is no record of the number of lives lost, if any.

From 1820 to 1836 there was no settlement on Galveston Island, although the Mexicans had built a small frame structure there in 1831 for a customhouse, but it does not appear to have been used for any length of time. In 1821 settlers began to arrive, passing up the bay, and located in the succeeding years at Harrisburg, Anahuac, and other points, but in none of the many records of the period from 1821 to 1836 is there mention of any destructive hurricane on the Texas gulf coast. This does not signify that there was none, but as all of the settlements, with very few exceptions, were inland, they would not have felt the effects of one to the same extent as the islands.

The year 1837 witnessed the beginning of Galveston, and by October, several buildings were under construction. Immigrants were coming in, and there were 20 vessels in the harbor. There were no wharves, and the Mexican customhouse was the only building on the island, the population being sheltered in tents and sod huts. On the 1st of October an easterly gale began blowing and continued with more or less intensity until the 6th, causing a very high tide and submerging most of the island. The wind then suddenly veered to the northwest and swept the waters of the bay down upon and across the island. The following account is extracted from the Telegraph and Texas Register (the first paper printed at Houston) of October 11, 1837:

> The late accounts from the seaboard are of the most distressing character. A tremendous gale appears to have swept the whole line of the coast and destroyed an immense amount of property It commenced on the 1st and increased in violence until the 6th. At Velasco four houses were blown down; the whole country for miles around inundated and all of the vessels in the harbor, consisting of the brig *Sam Houston*, and the schooners *De Kalb*, *Fannin*, *Texas*, and *Caldwell*, were driven ashore; the last named has since been got off and cleared on Sunday last for New Orleans. At Galveston the waters were driven in with such violence that they rose 6 or 7 feet higher than ordinary spring tide. They inundated a large portion of the east end of the island and compelled the soldiers of the garrison to desert their barracks, and seek shelter on the elevated ground near the intended site of Galveston City. The large new warehouse of Mr. McKinney and the new customhouse were completely destroyed and the goods scattered over the island. The brigs *Perseverance*, *Jane*, and *Elbe* were driven ashore, and are complete wrecks; the *Phoenix* is also ashore, but slightly injured, and may be easily set afloat again. The schooners *Select*, *Henry*, *Star*, *Lady of the Lake*, and the prize schooner *Correo*, are ashore, some of them high and dry. The *Tom Toby* (privateer) is a wreck, and the *Brutus* (Texan naval schooner) is considerably damaged. The schooner *Helen* is the only vessel which has received no damage. So far as we have been able to learn only two individuals have perished. The history of this country contains no record of any hurricane which has equaled this, either in the violence of the storm or the extent of the destruction. There is reason to believe that the destructive influence of this gale has extended gradually over the surface of the Gulf; we therefore apprehend that the next intelligence from the United States and from Mexico will be rife with accounts of disastrous shipwrecks. We sincerely trust, however, that neither the calamities of enemy or friend will equal our own.

Col. Amasa Turner, who was present, wrote as follows:

> There were about 30 vessels in Galveston Harbor when the great storm commenced on October 1, 1837. It began with a wind from the southeast and held to that quarter mostly for three days; then it vereed a little to the east and so continued until the sixth day, filling the bay very full and making a 4-foot rise at Houston. On the evening of the 6th, the wind veered to the northeast and blew very strong. The schooner, *Tom Toby*, a privateer, parted her cable and went ashore on